Flood Disasters and Indian Agriculture: An Economic Analysis of the Impact, Mitigation and Preparedness With Special reference to Uttar Pradesh

Synopsis

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Background

Disaster, a sudden calamitous event, seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community's or society's ability to cope using its own resources. In other words, disaster is a combination of hazards, vulnerability, and inability to reduce the potential negative consequences of risk. Though, often caused by nature, disasters can have human origins also.

Natural disaster is a natural phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. These may include earthquakes, landslides, flood, tsunamis, cyclones, pandemics, hurricanes, volcanic, eruptions, tornadoes, blizzards. Human-instigated disasters are the consequence of technological or human hazards. These include fires, transport accidents, industrial accidents, terrorist attacks, oil spills, explosions, nuclear and stampedes. War and deliberate attacks may also be put in this category. Other types of induced disasters include the more cosmic scenarios of catastrophic global warming, nuclear war, and bio-terrorism.

The rapid growth of the world's population and its increased concentration often in hazardous environments has escalated both the frequency and severity of disasters. With the tropical climate and unstable landforms coupled with deforestation, unplanned growth, non-engineered constructions, proliferation etc. make the disaster-prone areas more vulnerable. Few thinkers argue that all disasters can be seen as human-made, due to human failure to introduce appropriate emergency management measures (Blaikie, 2003).

Developing countries suffer more or less chronically from natural disasters due to ineffective communication combined with insufficient budgetary allocation for disaster prevention and management. These countries suffer the greatest costs when a disaster hits – more than 95 percent of all deaths caused by hazards occur in developing countries, and losses due to natural hazards are 20 times greater (as a percentage of GDP) in developing countries than in industrialized countries (World Bank).

Introduction

India is the fourteenth most vulnerable country in the world, due to its unique geo-climatic conditions and extreme weather-related events. Further, economic losses in India due to such calamities accounted

for around US$13,789 million in 2017, the fourth highest in the world. It is highly vulnerable to floods, droughts, cyclones, earthquakes, landslides, avalanches and forest fires (Global Climate Risk Index Report, 2019). As per National Disaster Management Authority (NDMA) out of 36 states and union territories in India 27 are disaster prone. Almost 58.6 percent of the landmass is prone to earthquakes of moderate to very high intensity, over 40 million hectares (12 percent) of land are prone to floods and river erosion, of the 7,516 km long coastline, close to 5,700 km is prone to cyclones and tsunamis, 68 percent of the cultivable area is vulnerable to drought and hilly areas are at risk from landslides and avalanches. Such vulnerable conditions have placed India amongst the top disaster-prone countries (Hindu Business Line, 3 January 2020). Studies show that the intensity, duration and frequency of weather-related shocks in India are likely to increase due to hasty climate change. The vulnerability to natural hazards is exacerbated by high population density and growth in urban and coastal areas.

The basic reason for the high vulnerability of India to natural disasters is its unique geographical and geological situations. As far as the vulnerability to disaster is concerned, the five distinctive regions of the country, i.e., Himalayan region, the alluvial plains, the hilly part of the peninsula, and the coastal zone have their own specific problems. While on one hand the Himalayan region is prone to disasters like earthquakes and landslides, the plain is affected by floods almost every year. The desert part of the country is affected by droughts and famine while the coastal zone is susceptible to cyclones and storms (Ministry of Home Affairs, 2019). In India rural vulnerability to hazards is high, particularly flood and drought risk, 66 percent of India's population lives in rural areas. Urban vulnerability to hazards is high given the rapid urban growth that is characterized by concentrated economic activity, unplanned developments, and growing slum populations. High population densities not only in urban areas, but also along large rivers and coasts, compound increasing vulnerabilities (World Bank 2019).

Flood: Meaning and Connotation

The input to rivers comes from rainfall and glacial melt; and output is finally into the ocean with local storage in lakes and reservoirs on the way. The discharge of a river is a function of channel width, channel depth and water velocity. During a heavy input, river is wider, deeper and faster, which results into flood. Thus, it is important to realize that floods are inevitable in a river system and they are expected to be repetitive. A flood becomes a hazard when life and property are exposed to the swirling

waters mainly because of human occupation of floodplains and other parts of the river basin. Flood can occur due to natural factors, such as storm, sudden melting of glaciers or bursting of a landslide blockade in the catchment area. Many floods are man-made when a civil engineering structure like a dam or an embankment is breached, or water is released from a reservoir during heavy rainfall in order to save a dam or a barrage.

Though floods are the most common and recurrent natural disaster in India, its frequency and intensity of occurrence have increased in the recent years. Floods are now occurring regularly in states where it used to occur once every ten years or more. Earlier, floods in India were restricted to areas like the Brahmaputra-Barak Valley, the Indo-Gangetic plains and the deltaic regions of Odisha, Andhra Pradesh and Kerala - which are riverine areas. Now, floods are occurring in small river valleys and even in hills, plateaus, and deserts. The phenomenon of urban floods is also increasing in recent times. Earlier, flooding was restricted to urban areas found on coasts or riverbanks, whereas now, even inland cities such as Bangalore and Jaipur get flooded (Drishti, 25 August 2018).

Flood in India

A large number of states in India are vulnerable to floods due to the geo-spatial distribution of rainfall, higher flood-prone areas, higher socio-economic vulnerability and inadequate resilient infrastructure across states to prevent flood risk. The major flood prone regions in India are Punjab, Haryana, most of the Gangetic plains including Uttar Pradesh, North Bihar and West Bengal, the Brahmaputra valley, coastal Andhra Pradesh and Orissa, and southern Gujarat (figure – 1). The north Indian plains are more vulnerable to floods than the southern ones, the flood-prone areas in the country can be broadly classified into three divisions.

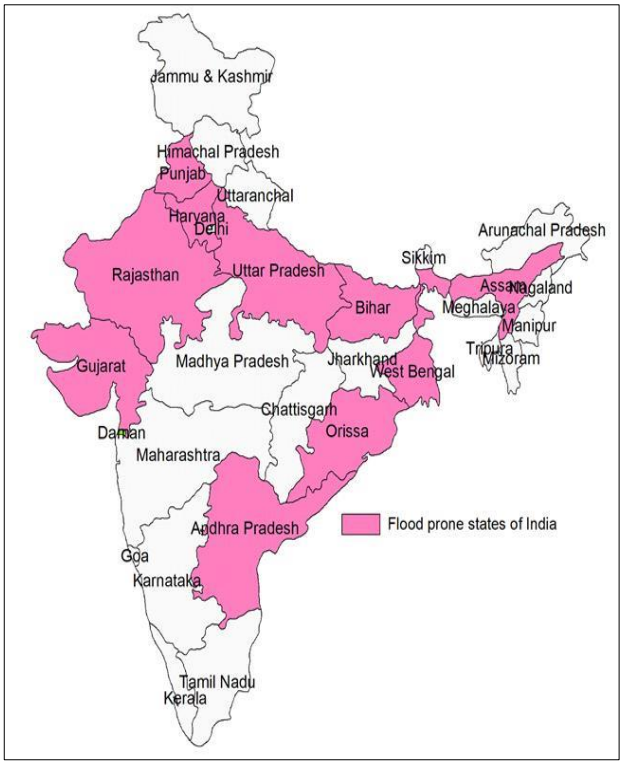

Figure – 1: Flood Prone States in India
(Source: http://www.nou.ac.in/Online%20Resourses/24-5/e-content%20_DM-Paper%20VII_%20-2.pdf)

Table-1 Land area under flood of flood prone states

State	**Flood area**
Uttar Pradesh	7.34
Bihar	4.26
Punjab	3.70
Rajasthan	3.26
Assam	3.15
West Bengal	2.65
Haryana	2.35
Orissa	1.40
Andhra Pradesh	1.39
Gujrat	1.39

*Land area under flood in million hectares.
(Source: http://www.nou.ac.in/Online%20Resourses/24-5/e-content%20_DM-Paper%20VII_%20-2.pdf)

The Ganga Basin: Ganga basin gets flooded mostly in northern part by the northern tributaries of Ganga river. The badly affected states of Ganga basin are West Bengal, Bihar, and Uttar Pradesh. Besides the Ganga, rivers like Sarada, Rapti, Gandak and Ghagra causes flood in eastern part of Uttar Pradesh. The Yamuna is famous for flooding Haryana and Delhi. Bihar experiences massive dangerous flood every year. River Burhi, Bagmati, Gandak, Kamla along with many small rivers contribute to floods in Bihar.

In West Bengal, rivers like Mahananda, Bhagirathi, Damodar, Ajay etc. cause floods because of tidal effects and constricted river channels.

Central India and Deccan Basin: In Orissa, the deltaic area formed by the Mahanadi, Baitarni and Brahman rivers is thickly populated. These rivers overflow at their banks, causing destruction in the area. Southern and central India observes floods caused by the rivers Narmada, Godavari, Tapti, Krishna and Mahanadi due to heavy rainfall. Cyclonic storms in the deltaic regions of Godavari, Mahanadi and Krishna occasionally flood the coastal regions of Andhra Pradesh, Orissa and Tamil Nadu.

Brahmaputra and Barak Basins: The banks of the Brahmaputra and Barak rivers get flooded due to surplus water in the Brahmaputra basin and the Barak basin. These rivers, along with their tributaries, flood the north-eastern states like West Bengal, Assam and Sikkim. The Jaldhaka, Teesta and Torsa rivers often overflow their banks and cause flooding in northern West Bengal, Manipur and Sikkim (Farooq, 2020).

Bihar is India's most flood-prone State, with 76 percent of the population in the North Bihar living under the recurring threat of flood devastation. According to some historical data, 16.5 percent of the total flood affected area in India is located in Bihar while 22.1 percent of the flood affected population in India lives in Bihar. Apart from Bihar, the badly affected states of the Ganga basin are West Bengal and Uttar Pradesh. Besides the Ganga, rivers like Sarada, Rapti, Gandak and Ghaghara causes flood in eastern part of Uttar Pradesh. The Yamuna is famous for flooding Haryana and Delhi. Bihar experiences massive dangerous flood every year. Cyclones invariably bring with them devastating floods. 13 coastal states and Union Territories in the country are affected by tropical cyclones and associated floods. Four states West Bengal, Andhra Pradesh, Odisha, Tamil Nadu and one UT (Puducherry) on the east coast, and Gujarat on the west coast are more vulnerable to the TCs (Farooq, 2020).

Determinants of Flood in India

Factors responsible for this state-of-affairs are natural as well as human made. The natural factors may include change in intensity, duration, pattern, and frequency of rainfall; cyclonic circulations and cloud bursts; erosion of riverbanks; inadequate load carrying capacity of rivers; drainage congestion; change

in topography from high mountains to plain areas; unexpected flows from trans-national rivers (Brahmaputra and many tributaries of Ganga); and unpredictably of local climate conditions.

The human made factors are unplanned development; encroachments in riparian zones; failure of flood control structures and of dams and drainage systems; weak infrastructure that do not meet global standards of resilience; unplanned reservoir operations; poor drainage; short-sighted infrastructure development policy; change in land use; sedimentation in riverbeds; and incapability to prevent natural ecosystems, e.g., forests, small tributaries, marshlands, lakes etc. This also affects groundwater recharge and degrades the general environment.

Flooding in the cities and the towns is a recent phenomenon caused by increasing incidence of heavy rainfall in a short period of time. The reason for this is indiscriminate encroachment of waterways and wetlands, inadequate capacity of drains and lack of maintenance of the drainage infrastructure. Apart from this, poor waste management system is exacerbating the problem by blocking drains, canals, and lakes, while ill-planned road projects are cutting off flood flows.

Flood and Indian Agriculture

Since ages, agriculture has been playing a vital role in developing Indian economy as it is the backbone for Indian economy. More than 70 percent of our rural people depend on agriculture for their livelihood and around 60percent of the land is occupied by agriculture activities (FAO, 2019). 18percent of India's gross domestic product (GDP) and 50percent of country's workforce is accounted by agriculture. Majority of Indians are dependent on agriculture directly or indirectly for their livelihood. The share consists of landowners, tenant farmers who cultivate a piece of land, agricultural labourers who are employed on these farms, and people doing business of agricultural products.

Next to China, India is the second largest fruit producer in the world. The production of horticulture crops was estimated at record million tons in 2017-18 (Horticulture at a glance, 2018). According to FAO (2019), India is the largest producer, consumer, and importer of pulses in the world. India is also among the top producers of rice, wheat, pulses, cotton, sugarcane, tea, tobacco leaves, spices, spice products, etc. The major kharif crops grown in India are rice, jowar, bajra, maize, cotton, groundnut, jute, sugarcane, turmeric, pulses, etc. The major rabi crops are wheat, oat, gram, pea, barley, potato, tomato, onion, oil seeds and the crops cultivated in Zaid are cucumber, bitter gourd, pumpkin,

watermelon, muskmelon, moong dal, etc. The driving forces that make these crops grow efficiently in India are the unique weather and soil conditions.

Flood, among others, is an important challenge that affects agriculture sector in India. Under the influence of climate change and economic development, the extent of floods is expected to increase (Jonkman and Kelman, 2005; IPCC, 2007). India is the most flood-affected nation in the world (Disaster Management in India, 2011, Ministry of Home Affairs, GoI). Flood was one of the costliest disasters in India in terms of disaster damage over the period 1970 to 2009 (World Bank2012). During this period, India experienced 192 floods which killed 48,000 people and, additionally, 783 million people were affected, and the resulting economic losses (63 percent) are the highest among the disaster-related losses. Flood disasters indirectly affect socio economic conditions of rural households by increasing poverty, food insecurity, and deteriorating human health by increasing water pollution levels in rivers and land degradation. It is also responsible for exacerbating farmer suicides in Indian states through poverty (Parida et al. 2018). Moreover, it directly affects rural labour market conditions through damage to crops (Roy Chowdhury et al. 2018).

The tangible and intangible losses due to floods in India are increasing due to over population and increased habitation, cultivation, and other developmental activities. Indian agriculture has experienced massive losses like crop losses leading to reduced yields, erosion of top fertile soil, damage to machineries, stored inputs, roads, etc. due to floods. Agricultural areas are frequently located in floodplain areas and therefore, this area is particularly targeted. Climate change is also another driver which intensifies the hydrologic cycle thereby increasing the magnitude and frequency of extreme floods. A report stated that land-use issues like decreased natural areas, loss of water bodies, encroachment of river/streams and other drainage channels, uncontrolled multiplication of built-up areas, are contributory factor to flood risk (Gupta and Nair, 2011).

Uttar Pradesh: Brief Profile

The State of Uttar Pradesh, which is land locked state, situated between latitudes 23o87’ N and 30o40' N and longitudes 77.08°' E and 84.63° E, has Uttarakhand and Himachal Pradesh on the northwest, Haryana and Delhi on the west, Rajasthan on the southwest, Madhya Pradesh on the south, Chhattisgarh and Jharkhand on southeast, Bihar on the east and Nepal on its northeast. The Himalayas provide the

northern, Yamuna - the western, Ganga - the southern, and Gandaki - the eastern boundary of the state. Based on its physical features, the state can be divided into three broad regions (i) Sub-Mountainous region, (ii) The Ganga-Plain region, and (iii) The Trans-Yamuna region. Climate of Uttar Pradesh is predominantly sub-tropical monsoon, mild and dry winter, and hot summer.

Figure 2 – Flood Zone in Uttar Pradesh

(Source: Ministry of Environment & Forest, GoI, http://www.upenvis.nic.in/Database/Disastermanagement_870.aspx?format=Print)

Natural disasters that are of significance in Uttar Pradesh are – floods, droughts, fires, and earthquakes. Loss of life and property from these disasters, especially the former three, are in terms of hundreds of crores of rupees annually. Uttar Pradesh is vulnerable from the aspect of man-made hazards too i.e., stampede, chemical, radiological, and other hazards. Eastern part of the state is traditionally flood prone but since last few years western Uttar Pradesh has also experienced massive flood situation (Ministry of Environment & Forest, GoI). Approximately 7.34-million-hectare area gets affected annually due to Floods. The annual loss due to floods is Rs. 432 crores approximately.

For geographical or seismic reasons, extensive areas in the flood plains of the Ganges and the Brahmaputra River systems continue to remain chronically flood prone. For these reasons, Uttar Pradesh is one of the most chronically flood prone areas in India. In Eastern Uttar Pradesh, which is high flood prone region, severely flood affected districts are Gorakhpur, Deoria, Basti, Sant Kabir Nagar, Siddharth Nagar, Mau, Maharaj Ganj, Kushi Nagar, Azamgarh, Ballia, Gonda and Bahraich (Singh, 2009).

In 2017 Uttar Pradesh accounted for 71 percent of total area affected and 45 percent of total cropped area affected due to flood in the country, but situation improved somewhat thereafter in 2018, total area affected, and total agricultural land affected was 9 percent and 18 percent respectively. During 2018 damage to crop was 230.36 crore which was 7 percent of total agricultural damage in India. Uttar Pradesh is a major contributor to the national food grain stock. In 2018-19 agriculture contributed 24 percent to the state's GSDP (CWC, 2019).

Present State of Knowledge

Floods are caused by natural conditions and phenomena (topography, rainfall), regional geographical conditions, and human activities that result in changes in land use in an area. (Kodoatie and Syarief, 2006) explained that the factors that cause floods include changes in land use, waste management, erosion and sedimentation, slums along rivers, improper flood control systems, high rainfall, river physiography, inadequate river capacity, effects of high tides, land subsidence, water structures, and damage to flood control structures. Based on their geographical conditions, areas located on floodplains have a high risk of being flooded.

Zahiran et al. (2008) mentioned that most floods damage occur as a result of extreme, intense and long duration floods caused by meteorological phenomenon such as prolonged and intense rainfall/precipitation, cyclones, storms, tidal surges and drainage modifications when combined with heavy rain. According to Doswell (2003), floods associated with rainfall are produced by thunderstorms and that, a single thunderstorm cell can produce enough rainfall to cause a flash flood. In terms of hydrological causes, floods can be caused by increased run off due to ice and snowmelt, impermeable land surfaces with saturated water, poor infiltration rates and land erosion (Stephen, 2012).

A review of recent literature assessing the impacts of natural disasters on economic growth shows a contrasting picture. Botzen et al. (2019) review shows that most natural disasters have direct economic

consequences, but only the less diversified economies have severe indirect effects leading to slowing economic growth. Shabnam (2014), however, shows a contrasting picture. Brown et al. (2013), using a fixed effect regression of a panel of 133 countries from 1961 to 2003, showed that droughts and floods constraint GDP growth. The findings of this report show that a one percent increase in flood and drought-affected areas reduce economic growth by 2.7 percent and 1.8 percent respectively.

Cavello et al. (2013) also used panel data from 1970 to 2008 of 198 countries but showed only extremely large disasters impact long-term economic growth. Loayza et al. (2012), using the generalized method of moments (GMM) on a cross country panel from 1990 to 2010, showed varying impacts of disasters on the economic growth of different sectors. Panwar and Sen (2020), analyzing a panel data of 102 countries from 1981 to 2015 with a system of generalized method of moments approach, also showed similar results of natural disasters on economic growth.

A recent study by Tang et al. (2019) used panel regression to assess the impacts of natural disasters in three regions. Using lagged terms of all control variables to control endogeneity, the study shows the heterogeneity of regional impacts, with meteorological disasters mostly affecting the central and eastern regions. Panwar and Sen (2020), using an augmented panel vector auto-regression model across 24 states of India, shows that floods have a negative effect on the short-term growth of all economic sectors except the agriculture. Only the severe floods have a statistically negative or non-significant effect.

According to Fisker (2012) and Shabnam (2014), the existing literature on the economic consequences of natural disasters is surprisingly inconclusive given that all recent studies have built their analyses on the same data source EM-DAT and most studies focus their attention on 5-year GDP growth rates. Some analysts have arguments for positive effects of natural disasters on economic growth (Albala-Bertrand, 1993; Skidmore and Toya, 2002; Loayza et al., 2009), and some suggest negative effects (Raddatz, 2007; Loayza et al., 2009; Noy, 2009; Cavallo et al., 2010).

Flood causes destruction of country's physical and social infrastructure, transport network, assets etc. which are often called ‘direct-damages’. Such damages create interruption in economic activities, i.e., change in production and/ or consumption behaviour, change in investment decision and so on, Okuyama, (2004) called these changes as ‘first order losses’. He traced direct damages and corresponding change in consumer spending and public/ private investment for extreme flood events

and estimates disaster losses, called ‘higher order effects’ or ‘induced effects’, which have arisen from inter-sectoral linkages in an economic system.

Field et al., (2012), in a report mentioned that small and medium enterprises and retail businesses have faced increasing risks and multiple vulnerabilities with recurrent floods year after year, and future climate change is expected to worsen these risks further by changing the intensity, frequency and duration of rainfall over the city. Kaspersen & Halsnaes (2016) conducted cost-benefit analysis of structural and non-structural adaptation measures by using survey data conducted on industrial SMEs and retail shops of Ansa Industrial Estate, Mumbai who suffered from large annual or sometimes multi-annual flooding damages.

The economics of geo-physical and societal aspects of flood events, the adaptation and mitigation measures have been discussed by several thinkers including Albala (1993), Agrawala et al. (2003), Okuyama (2004), Rose (2004), and Chowdhury, (2014); they addressed the economics of disasters in conjunction with sectoral and spatial levels. Brouwer (2006) and Banerjee (2010) discussed effects of flood particularly on agriculture sector, but they did not consider spatial variation and corresponding implication of such influences. Haque & Jahan (2015) investigated induced effects of flood disaster scenarios on national and regional output, income, and employment in Bangladesh through Input–Output model and urged that the government should consider regional variation while taking measures to tackle flood disaster.

Research Gap

After reviewing available literature, researcher observed following gaps in research.

- Though, considerable number of studies have been conducted globally to understand the effects of climate variability and hydro meteorological disasters on crop yields, there is no systematic study focusing on the economic impact of frequent floods on agriculture in India.
- Although, information about disasters in India is available in reports and websites of government departments dealing with relief and rehabilitation work, there is no study assessed loss of crop area, economic loss, and financial burden of floods in India especially in eastern part of Uttar Pradesh.

- There is no documented information about farmers' awareness, preparedness, and effectiveness of relief, rescue, and mitigation measures of flood disasters in reference to Uttar Pradesh, which is one of the most flood prone state of India and badly affected states of the Indo Gangetic basin.

The Problem

Preparedness for disaster is critical to the affected household, community, organizations, and government. This is cumulative endeavor to all sections of society. After a disaster, a community goes through four phases that overlap: the emergency period, the restoration period, the replacement reconstruction period, and the commemorative betterment period (Haas, Kates and Bowden, 1977). Combating a disaster require consists of pre- and post-disaster events which enables coping abilities of the affected community to respond effectively and recover quickly. The Pre-disasters preparedness includes the development of warning systems, evacuation planning, disaster communications, and public education and awareness. These are also called as mitigation measures because they need to be implemented well in advance (before happening) and minimize the adverse impacts of a hazardous event. The post-disaster mitigation may include the most immediate needs following a disaster (safe water, food, shelter, medical care etc.), recovery, reconstruction, rehabilitation, resilience, and retrofitting.

Even though the Disaster Management Act 2005 and the National Policy on Disaster Management 2009 prescribe 'integrating disaster risk reduction (i.e., mitigation) in the process of development across all sectors and at all levels', such a thing is yet to happen. The understanding of the dynamics of risks of disasters is far from comprehensive. For example, the multi-hazard early warning systems (EWS) do not work for floods. Even though rainfall can be predicted very accurately, there is no early warning system yet, for evacuating people from areas that are about to be flooded. This warning system works for cyclones only.

At least 44 years after India's first and last commission on floods was constituted, there is no national-level flood control authority in the country so far. National Flood Commission or the Rashtriya Barh Ayog (RBA) was set up by the Ministry of Agriculture and Irrigation in 1976, to study India's flood-control measures after the projects launched under the National Flood Control Program of 1954 failed to achieve much success. The RBA, in 1980 made 207 recommendations and four broad observations.

The first observation was that there was no increase in rainfall in India, thus, the increase in floods is due to anthropogenic factors such as deforestation, drainage congestion and badly planned development works; in the second observation, it questioned the effectiveness of the methods adopted to control floods, such as embankments and reservoirs, and suggested that the construction of these structures be halted till their efficacy was assessed. However, it did say that embankments could be constructed in areas where they were effective. In third observation, it said there has to be consolidated efforts among the states and the Centre to take up research and policy initiatives to control floods; and in the fourth, it recommended a dynamic strategy to cope with the changing nature of floods.

Need of Study

Natural disasters not only adversely affect the human and physical capital but also pose a serious threat to India's economic development. Parida & Dash (2019) confirms empirically that damages due to floods adversely affect the per capita Gross State Domestic Product (GSDP) growth across states. Moreover, frequent disasters also increase the fiscal pressure on the Centre and State government, besides worsening the social and economic conditions of the people. Natural disasters also increase farmer distress and are responsible for farmer suicides to a great extent. Parida, et al. (2018) mentioned that natural disasters, particularly drought and floods, increased farmer suicides in India due to crop damages.

The Indian Government has set a target of doubling farmers' income by the year 2022, to make India 5 trillion-dollar economy, and provide ease of living by 2024. These targets can only be achieved by improving the risk scenario of Indian agriculture and protecting it from natural disasters through proper adaptation or mitigation. Indian agriculture, like India's landscape is vulnerable to multiple natural and anthropogenic disasters and is also aggravated by the impact of climate change.

Floods in the Indian subcontinent have affected habitat, population, economy etc. The occurrence of floods cannot be stopped; but their damage can be minimized by proper management measures. It has three important pillars: (i) Preparedness – Before Flood, (ii) Relief and Rescue – During Flood, and (iii) Mitigation – After flood. It demands for effective policy making, efficient planning, and implementation. Due to the detrimental effects of recent floods on the economy, governance etc., it is

imperative to understand the associated dynamics, manifestations, and fallouts for proper policy planning recommendations.

Research Objectives

1. To examine intricacies and dynamics of natural disasters in India.
2. To present an analytical view on policies, systems, and government efforts for managing vulnerability of flood disasters in India.
3. To assess economic loss due to flood and analyse the impact of flood disasters on economic growth in India.
4. To examine farmers' awareness, preparedness, and effectiveness of relief, rescue, and mitigation measures of flood disasters in Uttar Pradesh.

Data and Research Methodology

To accomplish objectives of study, researcher proposed to use following methodology.

- The intricacies and dynamics of natural disasters, in terms of trend, pattern and causes of natural disasters in India will be examined by collecting secondary information from research papers, working papers, and reports on the subject, and the publications of National Disaster Management Authority (NDMA), Ministry of Home Affairs (MHA – GoI), National Institute of Disaster Management (NIDM), State Disaster Management Authority (SDMA),India Meteorological Department (IMD), National Disaster Response Force (NDRF), and other regulatory authorities. The collected information will be analysed by using trend analysis.
- The polices, systems, and strategies adopted by government for managing vulnerability of flood disasters in India will be analysed by using secondary information available in the publications/ website of National Disaster Management Authority (NDMA), Ministry of Home Affairs (MHA – GoI), National Institute of Disaster Management (NIDM), State Disaster Management Authority (SDMA), National Disaster Response Force (NDRF), and other regulatory authorities.
- The assessment of economic loss due to flood and analysis of the impact of flood disasters on economic growth in India – in terms of the affected crop area, crop loss, damage to property, death toll, and the total number of people affected by floods on the annual GDP per capita growth rate will be examined by using ordinary least square (OLS) method on dataset for flood events to be

collected from Emergency Events Database (EM-DAT) of Centre for Research on the Epidemiology of Disasters (CRED), United Nations Office for Disaster Risk Reduction (UNISDR), and Central Water Commission – Government of India (CWC-GoI).

- Farmers' awareness, preparedness, and effectiveness of relief, rescue and mitigation measures will be examined by using first-hand information. The required information will be collected by executing self-structured exhaustive questionnaire to farmers/ households of selected districts of Uttar Pradesh. The questionnaire will be designed by using Choice Experiment (CE) technique. The techniques of data analysis will include simple statistical techniques and Random Parameter Logit (RPL) model.

Data Duration

1991 – 2022 (Time series data for 32 years)

Sample Design

The history of flooding in Eastern Uttar Pradesh casts a dark shadow. The ecological and social settings through which flooding takes place in this region are diverse. For generations, floods have ravaged the lives of the inhabitants of this area with unrelenting regularity every alternate year and sometimes in subsequent years. The current trends witness serious flood problems in Eastern Uttar Pradesh. The results of these floods have been to reverse the gains on the development front.

The increasing trend in flood hazards in Eastern Uttar Pradesh has majorly resulted into loss of human life and livestock, destruction of field crops, destruction of shelter, massive erosion (in 2014, the year of devastation, 200 villages submerged in Bahraich region alone and some of them were erased from the map, Usama - 2015), loss of stored grains (due to floodwater), infrastructures and communication systems, sedimentation and silting on inhabited land, loss of livelihoods, and heavy indebtness.

The flood situation in Eastern Uttar Pradesh is divided into three categories, viz., the most affected areas, the medium affected areas, and the least affected areas. The most (highly) flood-affected (about 40 percent of Eastern Uttar Pradesh) districts (closest to the Himalayas) are Bahraich, Ballia, Basti, Gonda, and Kushinagar. The medium affected (about 33 percent of Eastern UP) are Varanasi, Jaunpur, Azamgarh, Deoria, Gorakhpur and Ghazipur, and the least flood affected districts are Pratapgarh, Sultanpur, Allahabad, Mirzapur, and Sonbhadra. (Singh & Srivastava, 2011). Researcher plans to draw

sample from five most flood affected districts of eastern Uttar Pradesh, viz., Bahraich, Ballia, Basti, Gonda, and Kushi Nagar (as per statistics of UP Remote Sensing Application Centre - UPRSAC).

For deciding sample size, researcher considered methodology given by Cocharn (1977) and Taro Yamane (1967). The sample size calculated by Cocharn's equation is 384, and by Yamane's method it comes 400. Accordingly, the researcher decided sample size of 400 respondents distributed in proportion of the number of cultivators in selected districts (see Table - 2). The election of respondents will be done on random basis.

Table-2: Sample Distribution

S. No.	District	Number of Blocks	Number of Villages	No. of Cultivators*	No of Respondents
1	Bahraich	14	1390	430227	105
2	Ballia	17	2361	206228	50
3	Basti	14	3348	296928	73
4	Gonda	16	1817	440340	107
5	Kushi Nagar	14	1639	265686	65
	Total	**75**	**10555**	**1639409**	**400**
***** Census - 2011 (Compiled), www.censusindia.gov.in. Cultivators in East UP: 44,84,081.					

Proposed Chapter Plan

Chapter 1: Background – An Assessment of Problem

Chapter 2: Theoretical Foundation and Review of Literature

Chapter 3: Dynamics of Natural Disasters in India

Chapter 4: National and State Policy Framework and Efforts for Flood Disaster Management – An Analytical View

Chapter 5: Impact of Flood Disasters on Economic Growth – An Analytical View

Chapter 6: Farmers' View on Preparedness, and Effectiveness of Relief, Rescue, and Mitigation Measures of Flood Disasters in Uttar Pradesh

Chapter 7: Potential Strategic Solutions and Conclusion

References

- Agrawala, S. Ota, T. Ahmed, A. Smith, J. and Aalst M. (2003). Development and climate change in Bangladesh: Focus on coastal flooding and the Sundarbans. Report No. COM/ ENV/ EPOC/ DCD/ DAC (2003)3/final. *OECD*. Paris.

- Alam, M.F., Pavelic, P., Sharma, N. and Sikka, A. (2020). Managed aquifer recharge of monsoon runoff using village ponds: Performance assessment of a pilot trial in the Ramganga Basin, India. *Water*. 12(4). 1028, Mpdi.doi:10.3390/w12041028.
- Albala-Bertrand, J.M. (1993). The political economy of large natural disasters: with special reference to developing countries. *Clarendon Press.* Oxford, UK.
- Albala-Bertrand, J.M. (1993). Natural disaster situations and growth: A macroeconomic model for sudden disaster impacts. *World Development.* 21(9).
- Banerjee, L. (2010). Effects of flood on agricultural productivity in Bangladesh. *Oxford Development Studies*. No. 38(3).
- Benson, C. and Clay, E.J. (2004). Understanding the economic and financial impacts of natural disasters. *Disaster Risk Management Series.* No. 4. World Bank. Washington-DC.
- Botzen, W.J.W., Deschenes, O. and Sanders. M. (2019). The economic impacts of natural disasters: A review of models and empirical studies. *Review of Environmental Economics and Policy*. Association of Environmental and Resource Economists. Vol. 13(2)
- Brouwer, R. Aftab, S. Brander, L. and Haque, E. (2006). Economic valuation of flood risk exposure and flood control in a severely flood prone developing country. *PREM Working Paper*. No. 06/ 02. *Poverty Reduction and Environmental Management.* Institute for Environmental Studies, Vrije Universiteit. Amsterdam, The Netherlands.
- Brown, C., Meeks, R., and Ghile, Y. (2013). Is water security necessary? An empirical analysis of the effects of climate hazards on national-level economic growth. *Philosophical Transactions of the Royal Society: A Mathematical, Physical and Engineering Sciences*. 371(2002): 20120416.
- Cavallo, E., Galiani, S., Noy, I., and Pantano, J. (2013). Catastrophic natural disasters and economic growth. *IDB Working Paper Series.* No. IDBWP-183. *Inter - American Development Bank (IDB).* Washington DC.
- Cavallo, E.A., Powell A., and Becerra, O. (2010). Estimating the direct economic damages of the earthquake in Haiti. *Economic Journal.* 120(546).

- Cocharn's equation ($n_o = Z^2.p.q/ e^2$) for calculating representative sample from a large population allows desired level of precision (e=0.05), confidence level (0.95), and the estimated proportion of attribute present in the population. Researcher assumes independence of attributes.
- Doswell, C.A. (2003). Flooding, *Elsevier Science Ltd.* No. 3.
- Drishti. (2018). Our understanding of the dynamics of risks of disasters is still far from comprehensive. Retrieved from https://www.drishtiias.com/daily-news-editorials/our-understanding-of-the-dynamics-of-risks-of-disasters-is-still-far-from-comprehensive.
- Farooq S. (2020). Flood prone states of India, http://www.geol-amu.org/notes/be1a-3-8.htm. Retrieved on 26 November.
- Field, C. B., Barros, V., Stocker, T. F., Qin, D., Dokken, D.J., Ebi, K.L., Mastrandrea, M.D., Mach, K.J., Plattner, G.K., Allen, S.K., Tignor, M. and Midgley, P.M. (2012). Managing the risks of extreme events and disasters to advance climate change adaption. *A Special Report of Working Groups I and II of the Inter-governmental Panel on Climate Change*. Cambridge University Press, New York.
- Fisker, P.S. (2012). Earthquakes and economic growth. Development Research Working Paper Series.Working paper No. 01/2012. *LaPaz: Institute for Advanced Development Studies (INESAD).*
- Floodbook. (2019). Water and Related Statistics. Flood Management Information System Centre, Irrigation and Water Resource Department. Uttar Pradesh. Central Water Commission. Department of Water Resources. RD & GR. October.
- Global Climate Risk Index Report (2019).
- Gupta, A.K. and Nair, S.S. (2011). Urban floods in Bangalore and Chennai: Risk management challenges and lessons for sustainable urban ecology. *Current Science.* Vol. 100. No. 11.
- Haas, J. Eugene, Robert W. Kates, and Martyn J. Bowden. (1977). Reconstruction following disaster. *Environmental Conservation,* 7(01) 82. The MIT Press, Cambridge, Massachusetts, and London. Retrieved from http://rwkates.org/pdfs/b1977.01_CH6.pdf.
- Haque, A. and Jahan, S. (2015). Impact of flood disasters in Bangladesh: A multi-sector regional analysis. *International Journal of Disaster Risk Reduction*. No. 13.

- Horticultural Statistics at a Glance. (2018). Horticulture Statistics Division. Department of Agriculture, Cooperation & Farmers' Welfare. Ministry of Agriculture & Farmers' Welfare, Government of India.
- India at a Glance. (2019). Food and Agriculture Organisation (FAO). United Nations.
- Jonkman, S.N. and Kelman, I. (2005). An analysis of the causes and circumstances of flood disaster deaths. *Disasters,* 29 (1).
- Kaspersen, P.S. and Halsnaes, K. (2016). Cost-benefit analysis of adaptation Investments for flood risk management for industrial estates in Mumbai. *Climate Change and Sustainable Development (CCSD) Research Group.* Department of Management Engineering, Technical University of Denmark (DTU).
- Kousky, C. (2014). Informing climate adaptation: A review of the economic costs of natural disasters. *Energy Economics.* 46. doi:10.1016/j.eneco.2013.09.029.
- Loayza, N., Olaberria, E., Rigolini, J. and Christiaensen. L. (2009). Natural disasters and growth going beyond the averages. *Policy Research Working Paper Series: 4980.* The World Bank.
- Noy, I.M. (2009). The macroeconomic consequences of disasters. *Journal of Development Economics.* 88(2).
- Okuyama, Y., Hewings, G.J.D. and Sonis, M. (2004). Measuring economic impacts of disasters: Inter regional input–output analysis using sequential interindustry model. *Advances in Spatial Science.* 77-101. Springer.
- Panwar, V., and Sen, S. (2020). Examining the economic impact of floods in selected Indian states. *Climate and Development.* 12.1-16.
- Parida, Y., and Dash, D.P. (2019). Rethinking the effect of floods and financial development on economic growth: Evidence from the Indian states. I*ndian Growth and Development Review.* Vol. 13 No. 3, pp. 485-503.
- Parida, Y., and Goel, P.A. (2020). India is not prepared for natural disasters. *The Hindu Business Line*. Retrieved from https://www.thehindubusinessline.com/opinion/india-is-not-prepared-for-natural-disasters/article30463153.ece.

- Parida, Y., Dash, D.P., Bhardwaj, P. and Chowdhury, J.R. (2018). Effects of draught and flood on farmers suicides in Indian states: An empirical analysis. *Economics of Disasters and Climate Change.* Springer. Vol. 2(2).
- Piers, B., Cannon, T., Davis, I. and Wisner, B. (1994). *At risk - natural hazards, people's vulnerability and disasters* (1st ed.). Routledge.
- Piers, B., Cannon, T., Davis, I., and Wisner, B. (2003). *At Risk- natural hazards, people's vulnerability and disasters* (2nd ed.). Routledge.
- Raddatz, C. (2007). Are external shocks responsible for the instability of output in low-income countries? *Journal of Development Economics*. 84(1).
- Rose, A. (2004). Economic principles, issues, and research priorities in hazard loss estimation. *Advances in Spatial Science.* 13-36. https://doi.org/10.1007/978-3-540-24787-6_2.
- Sapir, D.G., and Hoyois, P. (2012). Measuring the human and economic impact of disasters. *Foresight.* Government office of Science.
- Shabnam, N. (2014). Natural disasters and economic growth: A review, *International Journal Disaster Risk Science.* No. 5.
- Sholihah, Q., Kuncoro, W., Wahyuni, S., Suwandi, S. P., and Feditasari, E.D. (2020). The analysis of the causes of flood disasters and their impacts in the perspective of environmental law. *IOP Conference Series: Earth and Environmental Science.* Vol. 437012056.
- Singh, Gyaneshwar. (2009). A Report on the Natural Disasters in the Eastern Uttar Pradesh, India.
- Singh, K.K. and Srivastava, A. (2011). Report on immediate flood response in flood affected areas of eastern Uttar Pradesh (India). *Gorakhpur Environmental Action Group (GEAG).* Gorakhpur.
- Skidmore, M. and Toya, H. (2002). Do natural disasters promote long-run growth? *Economic Enquiry.* 40(4).
- Songwathana, K. (2018). The Relationship between natural disaster and economic development: A panel data analysis. *Procedia Engineering.* 212.1068–1074. doi:10.1016/ j.proeng.2018.01.138.
- Stephen, A.N. (2012). River systems and causes of flooding. https://www.tulane.edu/ ~sanelson/Natural_Disasters/riversystems.htm.

- Tang, R., Wu, J., and Ye, M. (2019). Impact of economic development levels and disaster types on the short-term macroeconomic consequences of natural hazard-induced disasters in China. *International Journal of Disaster Risk Science*. 10. Springer.
- The World Bank. (2012). Disaster risk management in South Asia: A regional overview. GFDRR.
- Tripathi, P. (2015). Flood disaster in India: An analysis of trend and preparedness. *Interdisciplinary Journal of Contemporary Research*. (2)(4).
- Usama, Mohammad (2015). Management of floods in flood prone regions of Eastern Uttar Pradesh. I*nternational Advanced Research Journal in Science, Engineering and Technology*. Vol. 2. Issue 11.
- The World Bank. Disaster Risk Management. https://www.worldbank.org/en/topic/ disaster risk management.
- Yamane's equation ($n = N/ (1+N(e)^2$) of sample size considers population size and the margin error at desired confidence level.
- Zahran, S., Brody, D.C., Peacook, G.W., Vedlitz, A. and Grover, H. (2008). Social vulnerability and the natural built environment: A model of flood casualties in Texas. *Disasters*, 32 (4).

Websites

- https://mausam.imd.gov.in
- https://nidm.gov.in
- https://ndma.gov.in
- http://www.fmiscup.in